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Tin Cans vs. Pots for Seedling Plants.

By

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It has been long observed in the work of propagation at this Station that young seedling plants, such as papaia, mango, avocado, Christmas tree, etc., grow more rapidly and with greater vigor in tin cans than in ordinary florist's pots. A set of experiments was carried out to determine the cause of the difference in growth. It was assumed, as a working hypothesis, that two factors were involved—a difference in evaporation and a possible stimulation due to the tin and solder of the cans.

For the first test two tin cans and two ordinary flower pots were selected. The cans were 3¾ inches in diameter and the pots 5 inches at the top and 3 inches at the bottom. All four containers received the same amount of potting soil by measure, approximately 760 grams. The potting soil was made by mixing 3 parts of ordinary clay soil, 3 parts of rotted manure and 2 parts of coral sand. It had been sterilized by heat, and in an air-dry state contained about 10 per cent of moisture. To each container 150 C. C. of water was added, bringing the moisture content up to 30 per cent. Holes were punched in the bottom of the tins and the pots had the usual drainage hole. The cans and

pots were weighed once or twice daily, and were brought back to the original weight by the addition of water, every other day at first and later every day.

During a period of 17 days the total loss of water by evaporation from the first can was 200 gm.; from the second can 220 gm.; from the first pot 491 gm.; from the second pot 489 gm. Averaging the loss from the cans and pots, the evaporation from pots was exactly 2½ times greater than that from tins. The soil was not shaken or in any way disturbed during the experiment. For the first few days the loss of water from the pots was three times that from the tin cans. At the end of the experiment it was only twice as great. The difference was thus gradually reduced as the soil became packed, reaching in about 10 days what seemed to be a permanent ratio of 1 to 2. The loss of water shown at each weighing was almost precisely the same for the 2 cans, and the same was true for the pots.

In a well ventilated laboratory room and in a ventilated glass-house the ratio of evaporation from tin cans and pots remained constant, but when exposed directly to the sun in the free air the tins showed a relatively greater increase of evaporation than the pots. This was due to the rapid penetration of heat through the tin. Evaporation was of course greatly affected by the humidity of the air. On a rainy day when the air was saturated with moisture the evaporation was only one tenth that of the following clear, dry night.

It was soon found that in order to secure results which were comparable from day to day it was necessary to bring the soil back to the original moisture content each day. Otherwise, on the second day, the soil on the surface of the pots, as well as that in contact with the sides becomes much drier than that in the tins, and the evaporation is thereby somewhat checked.

The porosity of flower pots varies greatly. Some of them allow the water to pass through so readily that an efflorescence of soluble salts is formed on the outer side of the pot. In order to compare the rate of evaporation from the exposed upper surface of soil in tins and pots a pot was heavily coated by dipping in melted paraffine, received the same moisture content as the others and was added to the series. No evaporation could take place through the side of this pot. The ratio of the surface of the soil in the tins and pots was as 1:1.5. The evaporation from the paraffined pot was 1.52 times as much as from the

tins, which corresponds very closely with the difference in exposed surface. It was to be expected that the difference in evaporation would be greater than the difference in exposed surface, for the reasons that the tins and pots contained the same amount of soil and that, therefore, the greater exposed surface in the pots entailed a relatively still greater proportion of the soil near the surface. In other words the soil in a pot is more exposed to evaporation than even the greater surface area would indicate.

In order to determine the relative amount of evaporation through the side of the pot and from the upper surface of the soil, another pot was added to the series. This pot was covered so as to prevent any evaporation from the upper surface of the soil. During the period of the experiment the sum of the loss from the upper surface of the paraffined pot and through the sides of the covered pot almost exactly equaled the average loss from the untreated pots. The average loss for a period of 3 days from the two untreated pots was 40 gms., and the sum of the loss from the paraffined and covered pots was 39 gms., the covered pot losing 18 gms. and the paraffined pot 21 gms. From these figures it is apparent that with the ordinary flower pot 52.3 per cent of the evaporation takes place from the top and 47.7 per cent through the side. The area of surface (side and bottom) of each pot in contact with the soil was 58.6 square inches, and the area of the top of the pot 17.8 square inches. From these figures and those of total evaporation it was easily calculated that the evaporation from a given area is 3.5 times as fast through a free surface of soil as through the side of the pot. The greater area of the side makes the evaporation from the side almost equal to that from the top.

Young uniform seedlings of a species of Schinus (Christmas tree or Hawaiian holly) were planted in 10 cans of the same size as those used in the above-mentioned experiments with the same quantity of potting soil, and also in 10 pots. Five of the cans and five of the pots were coated with paraffine to eliminate any effect which the containers themselves might have on plant growth. The plants in all the tins and in the paraffined pots received 60 C. C. of water every two days, and the unparaffined pots 120 CC. Of the latter 5 pots 2 were very porous while the other 3 were equally porous with those used in the simple

evaporation test. The plants were as near uniform as possible at the start. At 2 months of age the plants in the 2 very porous pots were 3½ inches high, those in the 3 medium-porous pots 4½ inches, those in paraffined pots 5¼ inches, those in paraffined tins 6¼ inches, those in untreated tins 7½ inches. The height and vigor of the plants showed a regular series of gradations, increasing in size as the evaporation from the container decreased (See fig. 1).

Fig. 1. Growth of young Schinus plants in different containers. From left to right: Very porous pot, medium porous pot, paraffined pot, tin can.

At the age of 2 months 2 plants in untreated pots and 2 in untreated tins were selected for daily weighings. The soil in all 4 containers was brought to a moisture content of 30 per cent, which was maintained by bringing it back daily to the original weight by the addition of water. For comparison the 2 pots and 2 tins from the previous experiment and without plants were added to the series. The loss of water by transpiration was calculated by subtracting the loss in the tins and pots without plants from the loss from the pots and tins with plants. For a period of ten days the total evaporation from the two tins without plants was 90 and 102 gms. respectively, and the

loss from the two tins with plants 301 and 295 gms. showing a transpiration of 211 and 193 gms. respectively. For the same period the evaporation from the 2 pots without plants was 186 and 201 gms. and the total loss from the pots with plants was 304 and 310 gms. giving a transpiration of 118 and 109 gms. respectively. At this stage of growth, therefore, the greater loss of water by evaporation from the pots was approximately balanced by the greater transpiration by the larger plants in the tins. A careful measurement of the leaf surface was made, indicating the leaf surface of the plants in tins to be 1.6 times greater than that of the plants in pots, while the transpiration was twice as great. The plants in tins were growing more vigorously and were obviously transpiring more water per unit of leaf surface.

During the period of 10 days just mentioned the 4 plants outstripped the rest of the group from which they were selected. They were of the same size at the start but at the end of the 10 day period the two plants in tins were 3 inches taller than the other 3 plants in tins and the two plants in pots showed a similar increased growth. This shows the importance of maintaining the optimum moisture content as uniformly as possible. The only advantage enjoyed by the four plants which made the greatest growth consisted in the fact that the original optimum moisture content of the soil was restored each day by adding precisely the amount of water lost by evaporation and transpiration during the preceding 24 hours, while the other plants received the same amount of water each day. On humid days this was too much and on dry days it was too little.

The great advantage of using tin cans rather than porous pots seems to rest in the fact that in tins it is easier to maintain a nearly constant moisture content without a rapid drying of the soil about the growing roots. This results in a more rapid and vigorous growth. Since nearly one-half of the evaporation from pots takes place through the side of the pot, the movement of this part of water is necessarily in a horizontal direction. Root growth responds to the direction of the water movements in soil. Therefore, the roots reach the side of the container more quickly and in greater numbers in pots than in tin cans. The difference in this regard is striking in all plants with which we have experimented (See fig 2). For example

seedling papaias, grown in pots, show a felted mass of roots on the outer surface of the ball of soil in the pot. After watering the soil rapidly dries by escape of water through the side of the pot, thus leaving the young rootlets too dry. By the shrinkage of the soil away from the side of the pot in drying a space is formed into which the water runs upon the next watering. The roots are thus alternately exposed to the air and submerged in water. In tin cans these conditions do not occur. No water can escape through the tin. The moisture content of the whole ball of soil is uniform and consequently the roots distribute themselves uniformly through the mass.

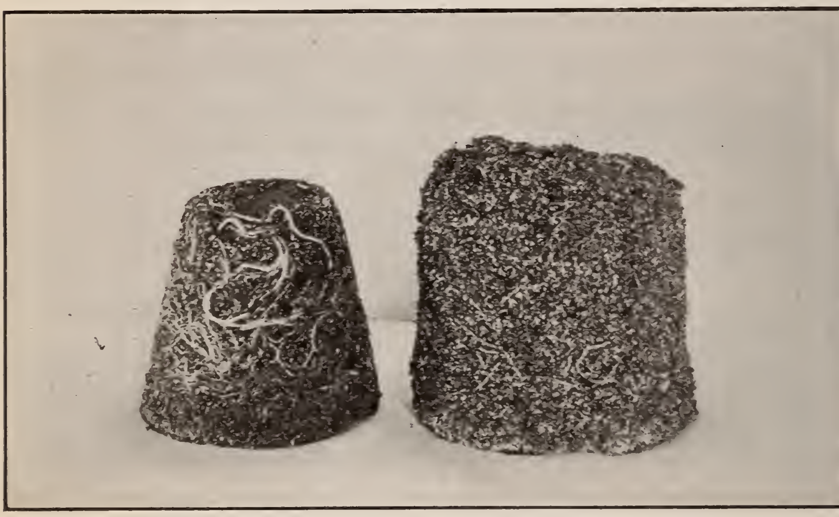

Fig. 2. Habit of root growth of papaia roots; on left in pot, on right in tin can.

When used in growing seedling plants tin cans show quite extensive disintegration within a year. Under the influence of oxygen, the soil solution and plant acids, salts of tin, zinc and iron are formed from the can and solder. The growing tips of rootlets come in contact with the side of the can, and are in position to absorb these mineral salts. Naturally the salts of the tin and zinc in the soil in tin cans must be in extreme dilution. Under these conditions tin and zinc are known to stimulate plant growth to some extent. Micheels[1] found that colloidal

1. Rev. Sci. (Paris) 5 ser. 5 (1906) pp. 427-429.

tin had a decided stimulating effect on wheat and oats. Nakamura[2] showed that zinc in great dilution was a marked stimulant. Similar results were obtained by Silberberg.[3]

In the experiments at this Station plants grown in untreated tin cans showed a better color and a more rapid growth than those in paraffined cans. In the paraffined cans the roots could not come in contact with the tin. Since all other conditions were the same it is necessary to conclude that the substance of the tin can itself exerted a slightly stimulating effect.

For the practical propagator these experiments indicate certain suggestions of considerable value. It is impossible to maintain the moisture content of the soil in porous pots as uniform as in tin cans, at least without watering them three or four times daily. Even then there are lateral movements of water through the side of the pot, which bring the roots to the outside of the ball of soil where the variation in moisture content is greater. In these experiments 5 inch pots containing 760 gms. of soil lost about 29 gms. of water daily by evaporation, while tin cans holding the same amount of soil lost about 12 gms. daily. The loss by transpiration depends of course on the size of the plant. A seedling Christmas tree 10 inches high transpires about 21 gms. daily, and one 5 inches high about 11 gms. These are average figures. The amount varies according to the humidity. It is obviously important to maintain the moisture content of the soil as nearly as possible at the optimum point. This can be determined approximately by a simple test similar to that on which this bulletin is based. A measuring device for watering may then be used by which approximately the right amount of water can be applied to each plant. In this way much better results will be obtained than by guessing, at the amount of water required.

The advantages of tin cans over porous pots are several. Flower pots are expensive in Hawaii since we have no material for manufacturing them and they must therefore be imported. Tin cans of various sizes cost nothing except the trouble of going to the pineapple canneries for them, where rejected cans may be obtained in almost any quantity. On account of the flaring top of pots they occupy about 1½ times as much space

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2. Bul. Col. Agric. Tokyo Imp. Univ. 6 (1904) pp. 147-152.
3. Bul. Torrey Bot. Club 36 (1909) pp. 480-500.

as tin cans holding the same amount of soil. Pots are easily broken in handling, while tins may be roughly handled without injury. The root development of plants is better in tin cans than in pots. The growth of plants in tins is faster than in pots, for the reason that a uniform moisture content is more easily maintained in tins. We find in practice that plants in tin cans will thrive well when watered only every third day, under conditions where plants in pots require watering every day. This brings about an economy in the cost of watering. Finally there is a slight stimulating effect from the disintegrating wall of the tin can.